PARABOLIC FLIGHTS AS EARTH ANALOGUE FOR SURFACE PROCESSES ON MARS.

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Introduction: The interpretation of landforms and environmental archives on Mars with regards to habitability and preservation of traces of life requires a quantitative understanding of the processes that shaped them. Commonly, qualitative similarities in sedimentary rocks between Earth and Mars are used as an analogue to reconstruct the environments in which they formed on Mars.

Limitations of Earth Analogues: Flow hydraulics and sedimentation differ between Earth and Mars, requiring a recalibration of models describing runoff, erosion, transport and deposition. Simulation of these processes on Earth is limited because gravity cannot be changed and the trade-off between adjusting e.g. fluid or particle density generates other mismatches, such as fluid viscosity. Computational Fluid Dynamics offer an alternative, but would also require a certain degree of calibration or testing.

Parabolic Flights: Parabolic flights offer a possibility to amend the shortcomings of these approaches. Parabolas with reduced gravity last up to 30 seconds, which allows the simulation of sedimentation processes and the measurement of flow hydraulics. This presentation summarizes the experience gathered during the four MarsSedEx campaigns of parabolic flights in the USA and Europe. During the flights, a range of instruments designed to measure settling velocity on Mars was tested. The parabolic flights aimed at identifying potential and limitations of their use as an Earth-based analogue for surface processes on Mars.

Mars Sedimentation Experiments (MarsSedEx): So for, four campaigns of sedimentation experimens have been conducted by the University of Basel. Three were flown onboard of Zero Gravity's G-Force One in November 2012, 2013 and 2015. The aim of MarsSedEx I, flown in November 2012, was a feasibility test for settling tubes, both in water and gas, as well as non-saturated movement of water in regolith. Building on this test, MarsSedEx II focused a year later on measuring settling velocities of a range of naturally occurring sand-sized particles under Martian gravity. MarsSedEx III in November 2015 aimed at detailed observations of regularly shaped particles to calibrate CFD models and a test of a settling tube that was equipped with four photometers to monitor the movement of clouds of silt-sized particles. The last experiment flown so far (MarsSedEx-STP) was part of the Second Swiss Microgravity campaign onboard Novespace's Airbus A-310, which was flown in October 2016. During this flight a set of eight settling tube photometers was used to measure settling velocities of mixtures of sediment and calibration matrial.

Conclusions: The MarsSedEx campaigns demonstrated that surface processes on Mars can be simulated during parabolic fligths. The results they generated also show differences in sedimentation between the two planets that include a significant underestimation of sediment settling velocities on Mars compared to Earth when using non-calibrated models, as well as less distinct sediment sorting on Mars than on Earth in similar runoff conditions.

Outlook: The success of the MarsSedEx parabolic flights paves the ground for the design of further experiments, aimed both at direct observations of hydraulic and sedimentary processes under Martian gravity, as well as the development of suitable sediment simlatnts and the calibration of sophisticated Computational Fluid Dynamics models to Martian gravity.

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References: [1] Kuhn N. J. (2014) Experiments in Reduced Gravity – Sediment Settling on Mars, Elsevier.